

PREPARATION OF READY TO EAT FLAKES OF SORGHUM [*Sorghum bicolor* (L)]

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ABSTRACT

The Sorghum flakes were prepared by two methods. The first method adopted by a local company, which manufactures cereal based flakes. Whole and de-hulled sorghum were separately soaked in water for 18 h to improve the moisture content. Moisture contents increased to 45% in de-hulled whereas 38% in whole grain respectively. Water was drained and grain was roasted in hot pan at 200 °C till popping sound. Then pressed in an edge runner and roller flaker to obtain fine flakes. Another method was developed by Dr. Kellogg, the process adopted in preparation of corn flakes. De-hulled sorghum was cooked in boiling water until the starch gets completely gelatinized. The time required for complete gelatinization of starch was determined by checking the complete disappearance of chalkiness when cooked grains is pressed between two glass plates, then tempered for 20 to 30 min in ambient air and then dried in tray drier at 70 °C and 15 min. The sorghum grits were then roasted for 11 min at 200 °C and then pressed in edge runner to obtain fine flakes. Color and overall acceptability were high in case of flakes obtained by the process described by Dr. Kellogg.

KEYWORDS: *Sorghum, Starch Gelatinization, Soaking, Roasting, Roller Flaker & Edge Runner*

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INTRODUCTION

Sorghum (*Sorghum bicolor* (L) Moench) is one of the four major cereals of the world being an excellent source of energy used both in animal & human nutrition. It follows wheat, rice and maize in area and production. Among the cereals without gluten used in food, sorghum has been characterized as a staple food for more than half a billion people in at least thirty countries (FAO, 2012). However, despite its consumption is expanding worldwide, the sorghum crop has not yet reached its productive potential. As it is devoid of gluten, sorghum is important in human nutrition. Breakfast cereals are crucial because they constitute the first meal of the day and are considered highly nutritious because they do not contain significant amount of fat and do contain important quantities of essential vitamins and minerals and are almost served with milk. Breakfast cereal products are convenient and practical because most do not need cooking and preparation and have a self-life. Breakfast cereals are divided into two broad categories: Hot or Ready to eat. Most are (RTE) because they do not need any further cooking at home. Efforts were made to retrofit rice flaking machinery to process jowar or sorghum flakes. The advent technology, edge runner (flaking machine) and roller flaker along with roaster has made possible to produce flakes from sorghum. Sorghum flakes are tasty and white as rice flakes. These flakes are pure form of consumption of jowar but offer a choice of convenience and ready to eat or cook products. Recipes such as pongal, upma or poha, porridge, chudwa, fried and seasoned mixtures etc., can be made from flakes. Sorghum flakes are suitable for all age groups, especially people ailing from diabetes and obese conditions, owing to content of slowly digestible starch in it. These flakes have more proteins, fat,

riboflavin, calcium, copper but less carbohydrates, magnesium, iron than rice flakes. Pyridoxine, folic acid and zinc are absent in rice but present in sorghum flakes. The objectives of the present study were to produce the sorghum flakes by following various processes and to evaluate sensory attributes and WATER ABSORPTION characteristics of flakes produced from different processes.

MATERIALS AND METHODS

The sorghum procured from the local market. It was cleaned to remove foreign matter.

Production of Sorghum Flakes

Different processes were followed in preparing sorghum flakes. They are

- Process adopted by Mathesis engineer's pvt.ltd.
- Traditional method developed by Dr. Kellogg for manufacturing corn flakes.

Process Adopted by Mathesis Engineer's Pvt. Ltd

Mathesis Engineer's pvt. Ltd manufactures cereal based snack food under the brand name NAVYA, located at Ramachandrapuram, Hyderabad. According to this method the grains were de-hulled in the de-huller and soaked in water for different time durations. The soaked grains are then roasted in a hot pan till the popping sound is obtained. Later the roasted grains are fed into the flaking machine to obtain flakes.

Method Developed by Dr. Kellogg

The de-hulled grains are cooked in boiling water until they get gelatinized. After gelatinization the water is drained. Now, the grain is tempered in ambient air for 20-30 min. The cooked grains have a translucent appearance and are partially dried in tray drier, grains are checked for moisture content. After obtaining the desired moisture content the grains are flaked in the roller flaker and edge runner (Morris B. Jacob., 1944).

Unit Operations Followed During Production of Flakes by Various Methods

Pre-Processing of Sorghum Grain

De hulling is performed to remove the bran layer of the grain. Without husk removal, it is impossible to explore the full potential of the grains. The machine is made in Central Institute of Agricultural Engineering (CIAE, ICAR); Bhopal has developed a machine for millet processing. The machine has a capacity of grinding 100 kg in an hour at 10-12 per cent moisture content. The separation of the husk is simultaneous with a suction arrangement and cyclone separator attached to the machine. After de hulling the grain is cleaned in a hand sieve for separating traces bran.

Soaking

Soaking is performed to increase the moisture content. Soaking of whole grain is done overnight (17 h) whereas soaking for de hulled grain is done for 3-4 h. it was done at ambient temperature and was maintained constant throughout the soaking process.

Cooking

Cooking is defined as combination of temperature, residence time and moisture content to fully gelatinize the starchy components in the formulate on. The temperature profile of the machine must be above the gelatinization

temperature of the starches found in the formulation.

Gelatinization

The breakage is eliminated and pasting properties of starch is improved by gelatinizing the starch which will fill the voids and cement the fissures and cracks in the grain.

Cooking Characteristics

Cooking performance of unbroken kernels was evaluated using the method described by (Chakrabathy et. al., 1972). The method involves placing small samples of grain in test tubes in boiling water until the starch is gelatinized. Gelatinization is determined by the absence of white chalky spots when kernels are pressed between two glass slides. Determining factors are:

- Cooking time
- The effect of soaking unbroken kernels for various periods up to 24 h at room temperature on water absorption and cooking time

Tempering

The cooked grain was left in the ambient air for 20-30 min to attain equilibrium moisture content.

Drying

Drying is a process of removal of moisture. Drying is generally performed in “tray drier” to get the required moisture content. Drying is performed to attain different moisture levels to check at which level good flakes can be obtained. Drying is performed in a tray drier, has pre filter at the inlet & adjustable damper at the outlet. Temperature control system is fully automatic done by electronic digital temperature controller.

Roasting

It was done in a hot pan heated on a LPG stove until popping sound comes which indicates puffing of the grain.

Flaking Process

Flaking is a size reduction operation. Flaking is done in two machines:-

- Roller flaker
- Edge runner

Roller Flaking Machine

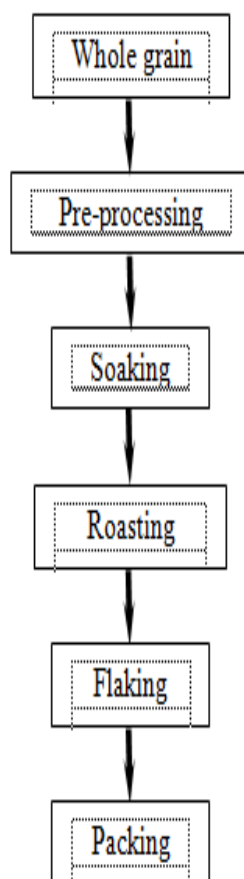
The soaked grains are fed into the machine by feeding hopper which consists of “fluted roller mechanism”. The capacity of the machine is 15 kg/h. The fluted rollers bring the grains from the feeding hopper to the mixing chamber. Mixing chamber is arranged with electrical heaters at the bottom and provided with rotating paddles to mix the grain to obtain equal heating and the heated grains are moved in forward direction. The heater has a thermo-sensor which cuts off at pre determined temperature. It was observed that at 194°C sorghum get popped. From mixing chamber grains are fed uniformly in between the two rollers by a trough like arrangement is made at the end of the chamber. Two rollers are made of steel and move in opposite direction, the clearance between the rolls is adjustable and is kept at less than the thickness of

the grain so that fine flakes can be obtained. A screen is placed at the discharge end from which the flakes falls from the rollers to the screen and it eliminates smaller particles or any damage is present. At last the flakes on the screen are collected into a tub.

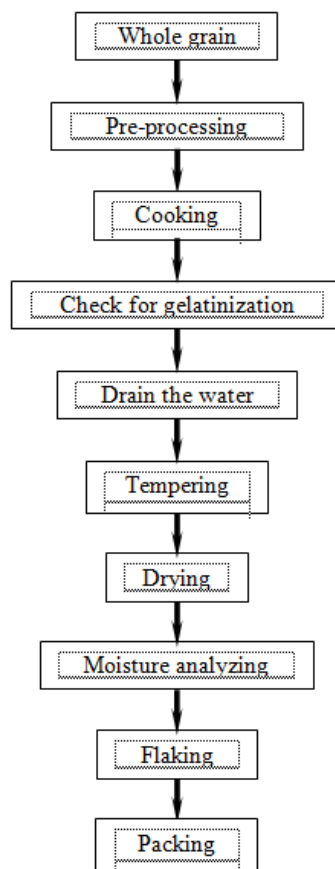
Edge Runner

This is a five hp motor driven mill has a 28 cm diameter roller inside a drum of 76 cm diameter. Both are made of cast iron. The roller revolves while the grain is being pressed and can be adjusted according to the thickness of flakes required. Pressed flakes can be collected near the centre of the drum.

Different Process Adopted for Preparing Sorghum Flakes are Described in Below Figure 2.1 and 2.2



**Figure 2.1: Process Flow Chart for Preparing Flakes (Mathesis Engineers Pvt. Ltd)
In Edge Runner and Roller Flaker**



**Figure 2.3: Process Flow Chart for Preparing Flakes
(By Dr. Kellogg) in Edge Runner and Roller Flaker**

Physical Properties

Moisture Content

Moisture content is determined by using Infrared moisture analyzer. It is an indirect method for measuring moisture content in grain. In this method, grain moisture content is directly measured by evaporation of water from a sample of grain with an infrared heating lamp. At the end of the test, a direct reading of moisture content is obtained in percentage (wet basis).

Total Drying Time

The total drying time was determined from the beginning of the tray drier to the desired moisture content of dried samples.

Sensory Evaluation

Different treatments of Sorghum flakes obtained by following different methods were analyzed by preliminary sensory panel to determine the sensory attributes of color, flavor/ aroma, tast, texture and overall acceptability. A balanced 9-point hedonic rating was employed for all the attributes evaluated. The acceptability statements and their marks used were given in table 2.1.

Table 2.1: Hedonic Rating

Rating	Reaction
9	Like extremely
8	Like very much
7	Like moderately
6	Like slightly
5	Neither like nor dislike
4	Dislike slightly
3	Dislike moderately
2	Dislike very much
1	Dislike extremely

Treatments

T₀: The flakes are prepared out of whole grain according to the Mathesis engineer's Pvt. Ltd. Process in the edge runner.

T₁: The flakes are prepared out of whole grain according to the Mathesis engineer's Pvt. Ltd. Process in the roller flaker.

T₂: The flakes are prepared out of de-hulled grain according to the Mathesis engineer's Pvt. Ltd. Process in the edge runner

T₃: The flakes are prepared out of de-hulled grain according to the method developed by Dr. Kellogg Process in the roller flaker.

Water Absorption Capacity (WAC)

The WAC was determined to the method (Beuchat 1997). Flake sample of 1g was taken in a test tube and filled with 10 mL of distilled water for 1 min and then centrifuged at 3000 rpm for 30-45 min. After separation of the content, the volume of supernatant was recorded and used for determination of WAC; the results are expressed as g/mL of sample. Four samples are taken for each treatment (sample-1, 2, 3 and 4).

RESULTS AND DISCUSSIONS**Production of Sorghum Flakes**

The experimental data obtained at different stages of preparation of flakes by method described by Methesis engineer's pvt. Ltd., are presented in Table 4.1.

Table 4.1: Production of Sorghum Flakes by Mathesis Engineer's Pvt. Ltd., Methodology

Sample. No	Pre-Processing	Soaking in Water		Moisture Content After Soaking (W.B)	Roasting Duration (Min)	Flaking Machine	Flaking Yield (%)
		Duration (H)	Water Temperature (Degree C)				
1.	Whole grain	18	27	35%	10	Edge runner	70%
2.	Whole grain	18	27.5	38%	11	Roller flaker	55%
3.	Whole grain	18	29	37%	11	Roller flaker	57.5%
4.	De-hulled	18	27.6	45%	11	Roller flaker	46.5%
5.	De-hulled	18	28	42%	13	Roller flaker	60%
6.	De-hulled	18	25	40%	15	Roller flaker	62.5%
7.	De-hulled	20	26.5	45%	10	Roller flaker	53%
8.	De-hulled	2	29	25%	9	Roller flaker	65%
9.	De-hulled	4	27	29.4%	No roasting	Roller flaker	35%
10.	De-hulled	12	27	35.5%	10	Roller flaker	80%

The table gives the duration of soaking (h), water temperature (degree C), roasting time (min) and flaking yield in the two different flaking machines.

When whole grain (samples 1, 2 and 3) were soaked in water at an average ambient temperature of 41.75 °C, attained in moisture content of average 36.6% after roasted to an average 10.6 minutes. Flaking yield was 70% in edge runner and average of 56.25% in roller flaker.

When de-hulled grain (samples 4, 5, 6 and 7) were soaked in water at an average ambient temperature of 26.77°C, attained in moisture content of average 43%, roasted to an average 12.25 minutes. Average flaking yield in roller flaker was 55.5%.

When de-hulled grain (samples 8, 9 and 10) were soaked in water for 2, 4 and 12 h, at ambient temperature of 27, 29 and 29°C, attained in moisture content of 25, 29.4 and 35.5% after roasted to 9, zero and 10 min. Flaking yield was 65, 35 and 80% in roller flaker.

The experimental data obtained at different stages of preparation of flakes by traditional method described by Dr. Kellogg, are presented in Table 4.2.

Table 4.2: Production of Sorghum Flakes by Dr. Kellogg. Methodology

Sample no	Pre-Processing	Cooking Time (MSSin)	Moisture Content After Cooking (W.B)	Tempering (Min)	Drying Time (Min)	Final Moisture Content (W.B)	Flaking Machine	Flaking Yield (%)
1.	Whole grain	75	60%	15	30	35%	Edge runner	75%
2.	Whole grain	75	62%	10	15	45.8%	Roller flaker	55%
3.	Whole grain	75	63%	1 night	No drying	20%	Edge runner	85%
4.	Whole grain	75	60%	1 night	No drying	20%	Roller flaker	70%
5.	De-hulled	45	56.9%	10	20	30%	Roller flaker	65%
6.	De-hulled	45	50%	15	20	25%	Roller flaker	60%
7.	De-hulled	45	55%	1 night	No drying	17%	Roller flaker	66%
8.	De-hulled	45	53%	1 night	No drying	17%	Edge runner	90%

The table gives the duration of cooking (h), improved moisture content % (w.b), roasting time (min) and flaking yield in the two different flaking machines.

Cooking time required for complete gelatinization of starch for whole grain was 75 min, average moisture content of improved was 61.25% and tempered for different durations and dried to different moisture levels. Flaking yield was 80% in edge runner and average of 62.5% in roller flaker.

Cooking time required for complete gelatinization of starch for de-hulled grain was 45 min, average moisture content of improved was 53.72% and tempered for different durations and dried to different moisture levels. Flaking yield was 80% in edge runner and average of 62.5% in roller flaker.

Sensory Analysis

The sensory scores for different treatments are given in table-4.3

Table 4.3: Flake Hedonic Ratings by Taste Panelists

Treatments	Mean Values of Panelists Score			
	T ₀	T ₁	T ₂	T ₃
Color score	8	6	6	8
Flavor score	8	7	6	8
Texture score	7	6	6	8
Over all acceptability	7	6	6	8

In treatment-T₀, the sample which was soaked for 18 h has a high score in color and flavor. In treatment- T₃, the sample which was cooked for 45 min has a high score in color, flavor, texture and overall acceptability.

Water Absorption Capacity

Table 4.4

Treatments	Sample 1 (ml)	Sample 2 (ml)	Sample 3 (ml)	Sample 4 (ml)
T ₀	4.9	4.9	4.9	4.9
T ₁	4.2	4.0	4.1	4.1
T ₂	5.2	5.1	5.0	5.1
T ₃	4.5	4.4	4.5	4.6

CONCLUSIONS

Now-a-days present generation is well mechanized and modernized in their life style. So, the daily routine of the human have changed a lot in all aspects including their diet. This sorghum flakes are instant breakfast food which do not need any cooking, boiling etc., these are more taken with milk.

Our experiment is also on the same basis to introduce a new product which is instant to prepare and easy to process. We have performed different experiments on flaking and successes by two different methods. One is method developed by Dr. Kellogg and another is process followed by Mathesis Pvt, Ltd.

The method developed by Dr. Kellogg was made successful by cooking (1 h) the sorghum grains for 45 min (de-hulled) and 1h for whole grain and checked for gelatinization and later tempered for one night or dried for 15 min and then tempered. Then the flakes are processed in roller flaker and edge runner.

Another method which is also successes is process followed by Mathesis Pvt, Ltd. These flakes are processed by soaking for overnight, tempered for 10min and the soaked grains are roasted in 11min in a heating pan and then flaked in both edge runner and roller flaker. At the end of our experiments we got ultimate results on edge runner when compared with roller flaker.

Sorghum flakes are also not so familiar to everyone and this production, successful results on sorghum flakes make them as a commercial product in the market which is also very useful for farmers and it becomes another revolution in some states especially in water scarcity areas like Telangana.

The above processes gave a good result for making such a ready to eat flakes and it also leads for the development and increases in number of industries and research centers which also bring many changes again and again and gives employment. This type of ready to eat flakes makes the daily morning simple, time saving without any burden in today's livelihood.

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